VOLUNTARY CLEANUP COMPLETION REPORT FOR COLUMBIA AND OLD PRO PATRIA MILL TAILINGS, AND SILVER SWAN MINE EAST WASTEROCK PILE RICO, COLORADO

Prepared for:

ARCO Environmental Remediation L.L.C.
307 E. Park Street, Suite 400
Anaconda, Montana 59711

Prepared by:

ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525

September 17, 1999

CERTIFICATION OF COMPLETION

ESA Consultants Inc. ("ESA") hereby certifies that the voluntary cleanup of **Columbia and Old Pro Patria Mill Tailings, and Silver Swan Mine East Wasterock Pile, Rico, Colorado** has been fully and properly implemented in accordance with the amended cleanup plan approved on March 4, 1996 by the Colorado Department of Public Health and Environment.

ESA attests that it is fully qualified and has sufficient knowledge in this matter to so certify because ESA has been responsible for providing ARCO with both technical and permitting support since the beginning of the voluntary cleanup process. Specific activities completed by the ESA project team in support of voluntary cleanup plan development and implementation are summarized as follows:

1. Preparation of the approved voluntary cleanup plan application, as amended, which includes the ESA's statement of qualifications and the qualifications of individual contributors.

2. Design analysis, as necessary, to develop mine waste removal and containment approaches that provide adequate permanent protection of human health and the environment.

3. Development of detailed construction design drawings and specifications under the supervision of an ESA registered Professional Engineer.

4. Preparation of all permit applications required for voluntary cleanup construction.

5. Engineering services during construction: 1) inspections for conformance with design specifications, 2) development of design modifications to address special conditions encountered during construction, 3) fill compaction verification testing, and 4) confirmation soil sampling and analysis for verification of waste treatment (agricultural lime) application rates and waste removal.

6. Post-construction services: 1) assistance with the construction completion report, 2) surface water quality monitoring and reporting (2-year program), 3) annual site stabilization inspections, repair, and maintenance operations, 4) annual vegetation surveys, 5) annual reporting of stormwater permit compliance monitoring results and corrective actions taken, and 6) preparation of the approved construction stormwater permit inactivation request.

Edmund J. Schneider, P.G.
Vice President
ESA Consultants Inc.

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Voluntary Cleanup Completion Report
For
Columbia and Old Pro Patria Mill Tailings, and Silver Swan Mine East Wasterock Pile
Rico, Colorado

1.0 INTRODUCTION

1.1 General

This report provides, or incorporates by reference, evidence in support of the ARCO Environmental Remediation L.L.C. petition for a "No Further Action" determination, subsequent to completion of the voluntary cleanup of the Columbia and Old Pro Patria Mill Tailings, and Silver Swan Mine East Wasterock Pile properties in Rico, Colorado. The voluntary cleanup plan for these properties has been developed, approved, and fully implemented in accordance with the Colorado Voluntary Cleanup and Redevelopment Act.

Information included in this report is summarized as follows:

- References for a variety of voluntary cleanup plan implementation reports (e.g. construction completion, maintenance, and surface water quality monitoring program) previously submitted to the Colorado Department of Public Health and Environment ("Department").

- Summary of cleanup objectives, site conditions, issues, and implemented remedial measures.

- Summary of permits/approvals acquired for construction, compliance reports, and releases.

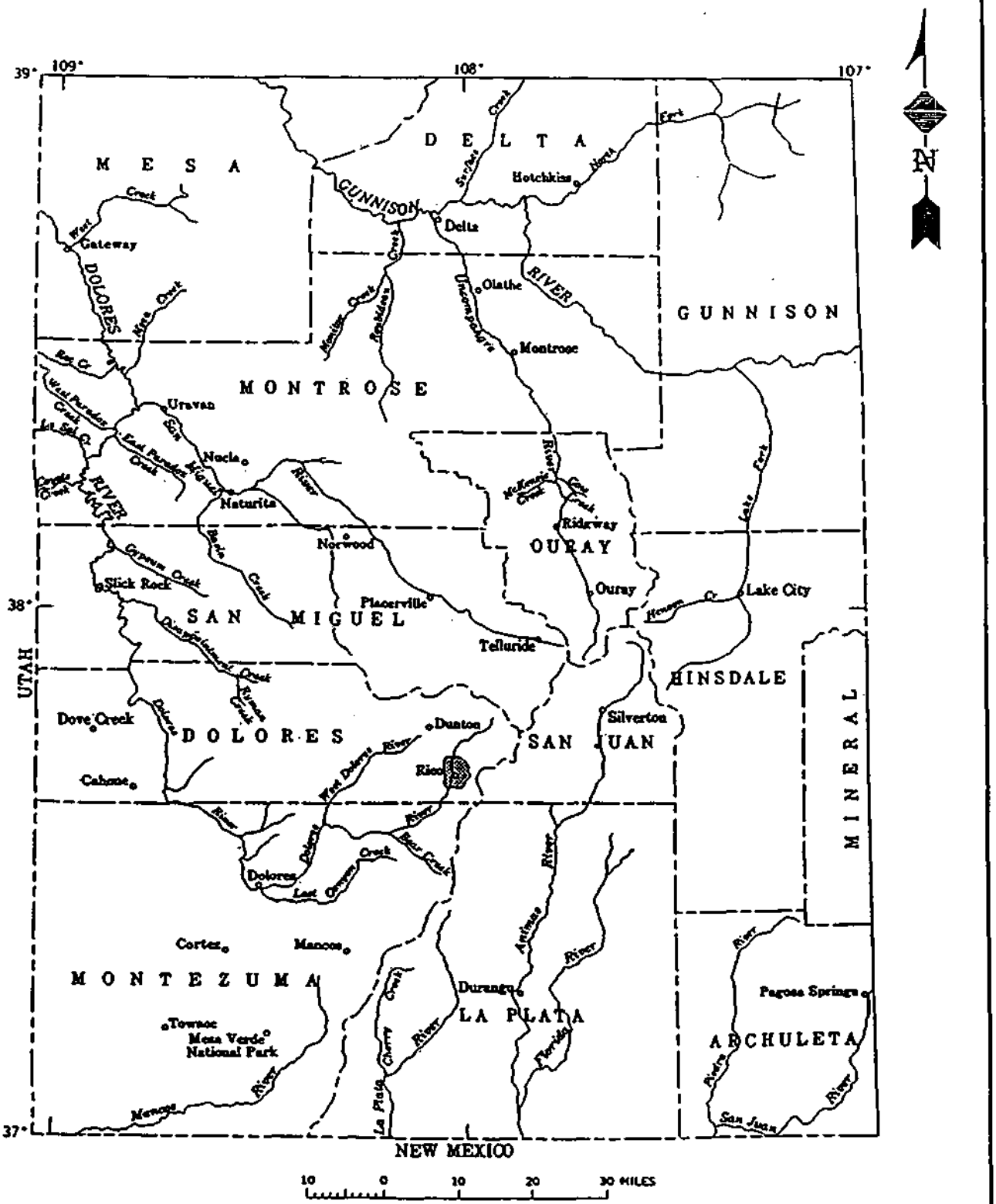
- Risk assessment based on the selected remedy for the designated land use of these sites.

Figure 1-1 shows the location of Rico in southwestern Colorado. Figure 1-2 shows the location of the three sites within the Dolores River valley in the Town of Rico. Inactivation notice information for the Columbia site mining stormwater discharge general permit certification is provided in the Appendix.

1.2 Cleanup Plan Implementation Reports and Notices

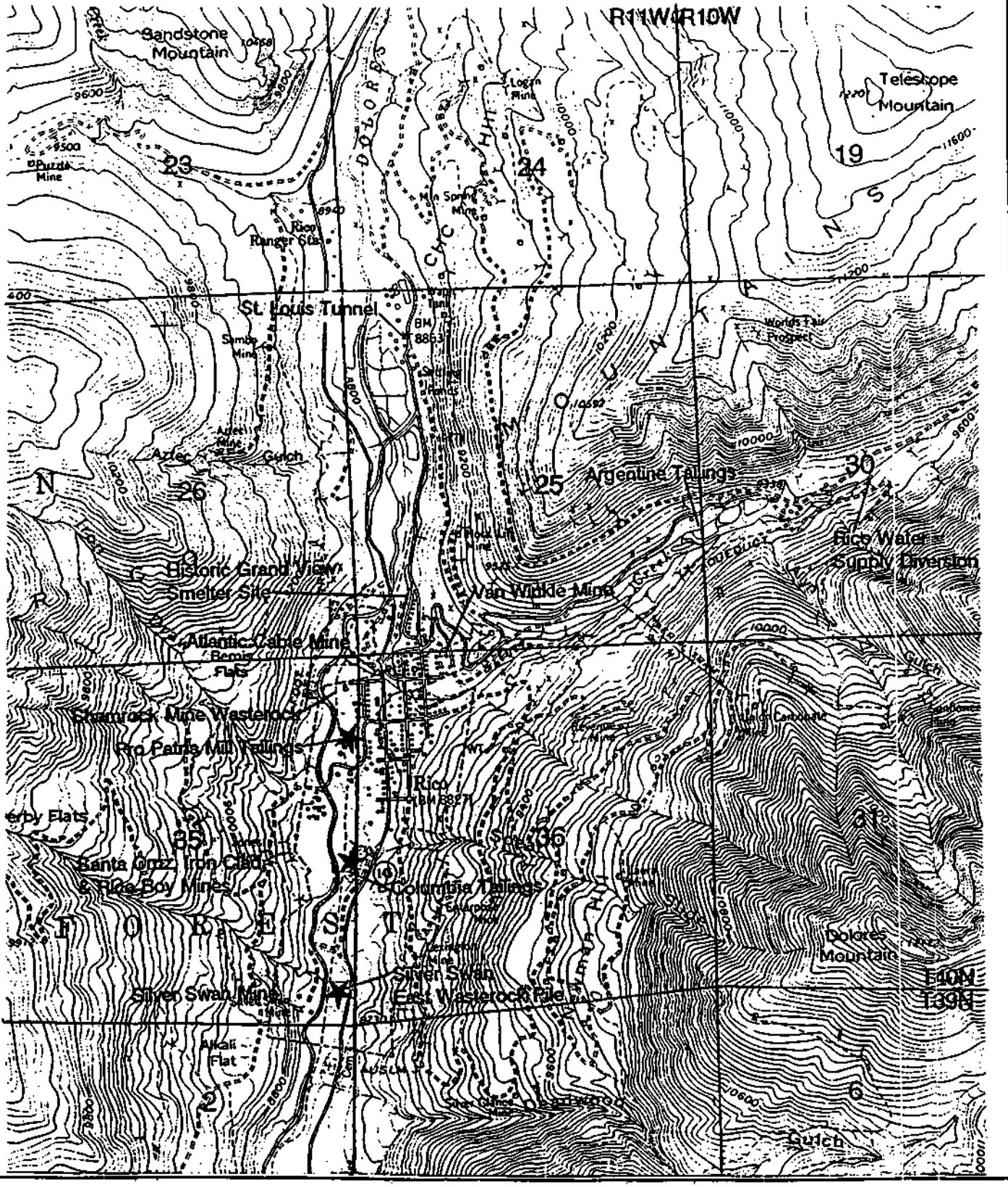
The following documents previously submitted to the Department and incorporated herein by reference provide substantial evidence that ARCO has complied with the voluntary cleanup plan, as amended and approved by the Department on March 4, 1996.

Voluntary Cleanup and Redevelopment Act Application for Columbia and Old Pro Patria Mill Tailings and Silver Swan East Wasterock Pile, Rico, Colorado. January 17, 1996. Atlantic



RICO DISTRICT
LOCATION MAP

FIGURE 1-1



0 1 MILE

CONTOUR INTERVAL 40 FEET

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COLUMBIA TAILINGS
SITE LOCATION MAP

FIGURE 1-2

Section lines added.
Base Map: USGS Rico Quadrangle, Colorado, 7.5 Minute Series.

Richfield Company, Los Angeles, Rico Properties, L.L.C., and Town of Rico. Submitted to Colorado Department of Public Health and Environment, Denver.

Rico Mining Area Construction Completion Report. January 1997. Atlantic Richfield Company, Los Angeles. Prepared by Anderson Engineering Co., Inc., Salt Lake City.

Rico Site Remediation Project 1997 Maintenance Completion Report. October 1997. ARCO Environmental Remediation L.L.C., Los Angeles. Prepared by ESA Consultants Inc., Fort Collins.

Rico Site Remediation Project Surface Water Monitoring Program Post-VCUP Interim Report. October 1997. ARCO Environmental Remediation L.L.C., Los Angeles. Prepared by ESA Consultants, Inc., Fort Collins.

Rico Site Remediation Project Surface Water Monitoring Program Post-VCUP Final Report. October 1998. ARCO Environmental Remediation, L.L.C., Los Angeles. Prepared by ESA Consultants, Inc., Fort Collins.

Rico Site Remediation Project 1998 Maintenance Completion Report. November 1998. ARCO Environmental Remediation L.L.C., Los Angeles. Prepared by ESA Consultants Inc., Fort Collins.

Inactivation Notice for Mining Stormwater Discharge Permit Certification No. COR-040188, with attached Technical Memorandum - Reclamation Monitoring Results for the Columbia Site. ARCO Application to the CDHPE Water Quality Control Division, signed October 1, 1998.

Inactivation Approval- Stormwater Discharge Permit Columbia Site, effective February 2, 1999. Letter to ARCO from the Water Quality Control Division, dated February 9, 1999.

1.3 Cleanup Goal and Objectives

The goal of the approved voluntary cleanup plan for the three historic mine waste disposal sites is to provide adequate protection of human health and the environment for the designated land uses of these sites. The essential objectives of the selected remedy addressed by the plan are to:

- Provide permanent solutions to eliminate or minimize, to the maximum extent practicable, the potential for release of mine waste constituents to surface and ground water systems.

- Prevent human ingestion of contaminated waste material in areas where inhalation of dust or direct contact could potentially pose an unacceptable health risk for the land uses designated in the voluntary cleanup plan.

- Prevent any unnecessary disturbance of the Dolores River during VCUP remedial activities.

2.0 SUMMARY OF PRE-CLEANUP SITE CONDITIONS AND ISSUES

2.1 Columbia Tailings

Major conditions and issues addressed by the cleanup plan for the Columbia tailings include:

- Land ownership: Portions of two private land tracts and one Town of Rico tract
- Area: 3.3 acres with contributary drainage basin area of about 58 acres; west side of tailings pile isolated from Dolores River active channel by historic railroad grade which forms east bank of the river at the site.
- Tailings pile volume and type of potential contaminants: 45,000 c.y. of historic sulfide ore mill tailings containing heavy metals (predominantly iron, lead, and zinc)
- Pre-VCUP land use: Undeveloped inactive mill tailings disposal site
- Future land use: Visitor center with access road from Highway 145, parking areas, open-air pavilion, and vegetated open space; within Town's proposed Dolores River corridor
- Issues: 1) tailings pile on east edge of Dolores River flood plain; 2) incidental human contact with exposed tailings; 3) surface water contact with tailings through direct rainfall/snowmelt, wetland ponding, and runon; 4) seepage from tailings into underlying ground water and Dolores River; and 5) river corridor aesthetics

2.2 Old Pro Patria Mill Tailings

Major conditions and issues addressed by the cleanup plan for the Columbia tailings include:

- Land ownership: One private owner; portions of two land tracts and eight lots
- Area: 2 acres; Dolores River flood plain
- Tailings pile volume and type of potential contaminants: 7,300 c.y. of historic sulfide ore mill tailings and waste rock containing heavy metals (predominantly iron, lead, and zinc)
- Pre-VCUP land use: Undeveloped inactive mill tailings disposal site
- Future land use: Open space; vegetated flood plain (meadow and wetlands); within Town's proposed Dolores River corridor
- Issues: 1) tailings pile in Dolores River flood plain; 2) incidental human contact with exposed tailings; 3) surface water contact with tailings through direct rainfall/snowmelt, wetland ponding, and runon; 4) seepage from tailings into underlying ground water; and 5) river corridor aesthetics

2.3 Silver Swan Mine East Waste Rock Pile

- Land ownership: One private owner; portions of two tracts
- Area: 0.1 acre; east bank of Dolores River
- Waste rock volume and type of potential contaminants: 600 c.y. of historic acid-generating sulfide ore-bearing rock containing heavy metals (predominantly iron, lead, and zinc)
- Pre-VCUP land use: Undeveloped inactive waste rock dump
- Future land use: Open space; vegetated flood plain (meadow and wetlands); within Town's proposed Dolores River corridor
- Issues: 1) waste in Dolores River secondary channel; 2) incidental human contact with exposed waste material; 3) surface water contact with waste material through direct rainfall/snowmelt and high river runoff; 4) erosion of waste material into river; and 5) river corridor aesthetics

3.0 SUMMARY OF IMPLEMENTED REMEDY

3.1 Major Components of the Remedy

Major components of the implemented remedy for mine waste material and reclamation of the three sites include:

- Reclamation cover to eliminate direct human contact with mine waste considering the proposed future use of the property.
- Consolidation and stabilization of mine waste-left-in-place against earthquakes and wind and surface water erosion to prevent off-site dispersal of mine waste material.
- Runon, runoff, and infiltration controls to eliminate or minimize transport of soluble mine waste constituents to ground and surface water receptors.
- Re-establishment of wetland and flood plain plant communities in designated waste removal areas (i.e., Pro Patria and Silver Swan east properties) to reclaim vegetative habitat consistent with surrounding river corridor.
- Development of minimal facilities (e.g., access road, parking area, and kiosk) for future use of Colombia site as a visitor center with vegetated habitat consistent with surrounding river corridor.

3.2 Waste Removal and Consolidation

Consolidation activities at the Columbia tailings site have reduced the net area of waste-left-in-place by over 2 acres. Engineered mine waste consolidation measures were implemented to reduce the total area of land containing waste-left-in-place within the Dolores River corridor and completely remove waste materials as non-point sources of potential pollution from selected areas. Mine waste was completely removed from the old Pro Patria mill (7,300 c.y.) and Silver Swan mine east (600 c.y.) sites, and consolidated at the Columbia tailings site. Consolidation activities also included removing mine waste from selected areas on the south and north side of the Columbia property, and along the east side to accommodate construction of a surface water diversion ditch.

Verification of waste removal was accomplished through confirmation sampling and analysis of the underlying soil. Waste removal was considered complete, as described in the cleanup plan, after all waste material was confirmed by visual inspection and the soil sample analysis results indicated a zinc content of below or within the range of the natural background concentrations. Confirmation results are provided in the referenced construction completion report.

3.3 Hydrologic Controls

Engineered hydrologic controls for runon, runoff, infiltration, and flood protection have been constructed to permanently prevent or minimize water contact with waste material and achieve permanent containment of waste-left-in-place on the Columbia property.

Waste pile surface re-configuration and reclamation cover. The reclaimed tailings pile is graded, compacted, and protected by a reclamation cover for erosion protection and infiltration control. Compaction depth is 18 inches. Top of pile is graded to 3 percent slope to prevent ponding of surface water, safely shed site runoff, and reduce infiltration. Outslopes are graded to 4H:1V to increase slope stability against erosion and slumping. The reclamation cover is described below.

Surface water diversion ditch. A lined and riprapped drainage diversion ditch, about 1,000 feet in length, intercepts all runoff entering the site from the east and south. The ditch is sized for the estimated peak runoff from a 100-year design storm event. All intercepted runoff is diverted around the reclaimed waste pile through a sedimentation control basin on the southwest end of the property. This basin ultimately drains to the Dolores River side channel through a culvert in the historic railroad grade downstream of the waste pile.

Dolores River flood protection revetment. About 1,700 c.y. of bedded riprap have been placed along a 1,200-foot reach encompassing the north side of the tailings pile and the east bank of the Dolores River formed by the historic railroad grade. This river bank stabilization revetment is sized to protect against the peak flow velocity and stage estimated for a 500-year design flood event with 2 feet of freeboard.

3.4 Reclamation Cover

A stabilizing reclamation cover placed on the consolidated waste pile surface, and all waste removal areas provides for permanent protection against wind and water erosion, infiltration control, protection against human and wildlife contact with waste materials, and enhancement of river corridor aesthetics. Components of the reclamation cover are summarized below.

Lime amendment. The top 6 inches of the graded, Columbia waste pile has been treated with agricultural lime at application rates ranging from 125 to 500 tons/acre to neutralize potential acid generation. See construction completion report for application rate determination procedures and analysis results.

Growth medium. The Columbia waste pile is covered with 24 inches of clean, rocky soil. Waste removal areas are covered with 6 to 12 inches of clean soil. A local source of soil borrow material free of mine waste and debris was developed for this site. The borrow area was closed and revegetated after completion of site cleanup.

Vegetation cover. Three different seed mixtures of native grasses and forbes (general upland mix, slope stabilization mix, or wetland mix) have been used where appropriate to establish a protective vegetation cover on all disturbed areas. Fertilizer and hydromulch amendments were applied at the time of seeding to enhance plant establishment. Seed mixture and amendment application rates are provided in the construction completion report. The surface stability criterion proposed to the Department (Water Quality Control Division) under the stormwater discharge permit program was achievement of a minimum average cover of 50 percent combined plant and rock fragments.

Initial seeding of all disturbed areas designated for vegetative cover was completed during the second week of October 1996. Two annual revegetation inspections have been performed since construction completion, one in July 1997 and the other in September 1998 near the end of the growing season. Drought conditions in June 1997 prevented development of adequate plant cover during the first growing season at the Columbia site. Consequently, the site was replanted in October 1997.

Quantitative results for the 1998 Columbia site inspection indicate a stable surface has been achieved on the reclaimed waste pile and removal areas. Plant cover on the reclaimed waste pile averaged about 32 percent (range of 23 to 42 percent) and the rock fragment cover averaged about 42 percent (range of 26 to 51 percent), resulting in a total average surface cover of about 74 percent. Similar results have been estimated for the reclaimed Pro Patria and Silver Swan mine east removal areas.

Gravel and geotextile. The Columbia site access road loop and parking areas consist of a compacted subgrade reinforced with Geogrid fabric to prevent road damage from vehicle loading on soft ground conditions, an 8-inch thick compacted aggregate road base, and 3 inches of gravel surfacing material.

4.0 CONSTRUCTION/ACCESS PERMITS AND RELEASES

4.1 Permits

The following listed permits were obtained by ARCO as required to implement the approved voluntary cleanup plan. No other approvals were required to implement the plan.

- Stormwater Discharge Permit, CDPS Permit No. COR-O40188; request for termination approved by the CDPHE and permit inactivated effective February 2, 1999.

- Corps of Engineers Nationwide General Permit No. 38, Cleanup of Hazardous and Toxic Wastes; expiration date was January 21, 1997.

- Colorado Department of Transportation ("CDOT") State Highway Access Permit No. 596080; provides property owners CDOT permission for access to the Columbia site from State Highway 145. This permit remains valid unless at any time the permitted access and its use violate any of the terms and conditions of the permit.

4.2 Inactivation of Columbia Site Stormwater Discharge Permit

As noted above, the stormwater discharge permit has been terminated based on the plant and rock fragment cover achieved, observed stability of the site surface, and the construction of other permanent hydrologic control structures. The Technical Memorandum describing the reclamation results for the site, as submitted with ARCO's request for termination of the stormwater discharge permit, is provided in the Appendix.

5.0 RISK ASSESSMENT

A key consideration in assessing risk associated with reclaimed consolidated mine waste left-in-place at the Columbia tailings site is the extent of human or environmental exposure when the property is used for the purposes identified in the approved voluntary cleanup plan (visitor center with access road from Highway 145, parking areas, open-air pavilion, and vegetated open space). Completion of the voluntary cleanup has achieved reduction of risk to human health and the environment through the following:

- Removal of contaminated mine waste from the banks of the Dolores River and remediation of consolidated waste-left-in-place minimizes human and environmental exposure pathways.

- Stabilization of contaminated waste-left-in-place provides long-term minimization of human and environmental exposure pathways.

- Control of access and covering of exposed contaminated mine waste prevents direct human contact and minimizes human exposure pathways.

To assure the protection of human health, and to protect against environmental releases, effective closure of mine waste left-in-place has been achieved by waste consolidation and construction of several permanent and durable non-point source waste containment measures. For long-term effectiveness, emphasis was placed on "passive-care" approaches. These measures prevent direct human contact and provide long-term control of major contaminant migration pathways, including wind and surface water erosion, contaminated surface water runoff, and infiltration and seepage. Consequently, these measures eliminate or effectively reduce potential mine waste impacts to: 1) the beneficial uses of the waters of the State, 2) surrounding ecosystems, and 3) human health due to adsorption, ingestion, and/or inhalation of waste particles.

In addition, post-remediation monitoring and maintenance activities provide evidence that the properties, when used for the purposes identified in the cleanup plan, are protective of human health and the environment. Results of annual site stabilization inspections required under the Department's stormwater discharge permit program verified that the structural measures (such as flood protection, drainage diversion structures, and waste pile reconfiguration) are functioning as designed.

Results of the annual inspections have also verified the stability of the surface cover. Proposed surface stability criterion for adequate plant and rock fragment cover protection of the reclaimed mine waste pile and waste removal areas were achieved by the end second growing season. The proposed stability criterion were approved by the Department (Water Quality Control Division) under the stormwater discharge permit program. As discussed above, achievement of adequate site stability has resulted in the inactivation of the stormwater discharge permit (see Appendix).

Pre- and post-remediation surface water quality monitoring results support evidence from the annual site stabilization inspections that the properties remain protective of human health and the environment. Monitoring results indicate that dissolved metals loads from the Columbia tailings side channel do not impact beneficial uses of the Dolores River. Although a reduction in dissolved metals loads to the side channel could not be confirmed during the two-year post-remediation monitoring program, concentrations of selected dissolved metals in the Dolores River downstream of the Columbia tailings site continue to be consistently below cold water aquatic life standards. Measured pH values were also consistently above 7.0 one year after construction and no cyanide has been detected in the river side channel. Furthermore, use of the Dolores River for water domestic water supply in the vicinity of the site does not exist. Likewise, use of ground water for domestic supply also does not exist in the immediate vicinity or down gradient of the Columbia tailings site.

In addition to the implemented remedial measures, site accessibility constraints further reduce potential human health risk by limiting the opportunity for direct human contact. New facilities constructed to accommodate the proposed future use of the Columbia site as an open space visitor center serve as supplemental control measures to protect the integrity of the reclaimed waste pile or control site access. These facilities include: 1) engineered access road and parking facility for cars and recreation vehicles, 2) durable shelter structure (kiosk), and 3) security gate, guard rail, and fencing for vehicle control.

APPENDIX

INACTIVATION STORMWATER DISCHARGE PERMIT

STATE OF COLORADO

Bill Owens, Governor
Jane E. Norton, Executive Director

Dedicated to protecting and improving the health and environment of the people of Colorado

4300 Cherry Creek Dr. S.
Denver, Colorado 80246-1530
Phone (303) 692-2000
Located in Glendale, Colorado

Laboratory and Radiation Services Division
8100 Lowry Blvd.
Denver CO 80220-6928
(303) 692-3090

http://www.cdphe.state.co.us

Colorado Department
of Public Health
and Environment

February 9, 1999

Atlantic Richfield Company
ATTN: Chuck Stilwell
307 E. Park Street, Suite 400
Anaconda, MT 59711

Re: Inactivation - Stormwater Discharge Permit
Columbia Site
CDPS Permit No. COR-040188
Dolores County

Dear Mr. Stilwell:

This office has reviewed your request for termination of the above-referenced permit. You have certified that your site has been stabilized. It is our opinion that this site does not require a stormwater discharge permit at this time. Your permit has been inactivated effective February 2, 1999.

We have prorated your annual fee pursuant to Section 6.16.(5)(A)(B) of the Permit Regulations which state:

> "Once the Division proceeds to terminate a permit at the permittee's request, the prorated fee shall apply to the period of time the permit has been in effect including, but not exceeding, ninety (90) days from the date the permit termination request is received by the Division."

Your prorated amount for the 1998-1999 annual administrative fee is $31.00 which covers the period July 1, 1998 through February 2, 1999. A refund in the amount of $22.00 is being sent under separate cover.

If you have any questions about the fee or the inactivation, please contact me at (303) 692-3503.

Sincerely,

Charlene Montgomery
Administrative Assistant
WATER QUALITY CONTROL DIVISION

cc: Ed Schneider, ESA Consultants, 2637 Midpoint Dr., Ste. F, Ft. Collins, CO 80525-4415
Local Health Department
File

/cm

Colorado Department of Public Health & Environment
Water Quality Control Division
WQCD-P-B2
4300 Cherry Creek Drive South
Denver, Colorado 80246-1530

FOR AGENCY USE ONLY			
rec			
eff			
	Year	Month	Day

INACTIVATION NOTICE FOR

MINING STORMWATER DISCHARGE GENERAL PERMIT CERTIFICATION

Please print or type. Form must be filled out completely.

Certification Number: COR-04 0 1 8 8 Taxpayer ID or EIN 954609777
–OR– COG-50 _ _ _ _

Permittee (Company) Name: Atlantic Richfield Company

Permittee Address: ARCO Environmental Remediation
444 South Flower Street
Los Angeles, CA 90071 Phone No. (213) 486-8309

Mine/Facility Name: Columbia Site

Mining Site Address/Location: Highway 145, Rico

County: Dolores Contact Person: David M. Romero

Reason/justification for inactivation, and description of final site stabilization. (Attach any supporting documentation, such as proof of Mined Land Reclamation Board bond release): Voluntary remediation of this inactive mine waste pile was completed in October 1996. The attached Technical memoranda provides a summary of site characteristics, permanent remedial measures, reclamation results, and proposed success criteria revision for this site.

I certify under penalty of law that by the date of my signature below, all disturbed soils at the identified mining site have been finally stabilized; all temporary erosion and sediment control measures have been removed; all mining and equipment maintenance waste have been disposed of properly; and all elements of the Stormwater Management Plan have been completed.

I understand that by submitting this notice of inactivation, I am no longer authorized to discharge stormwater associated with mining activity by the general permit. I understand that discharging pollutants in stormwater associated with mining activities to the waters of the State of Colorado, where such discharges are not authorized by a CDPS permit, is unlawful under the Colorado Water Quality Control Act and the Clean Water Act.

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein, and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. (See 18 U.S.C 1001 and 33 U.S.C. 1319.)

David Romero — 10/1/98
Signature of Permit Applicant (Legally Responsible Party) — Date Signed

David M. Romero — Project Manager
Name (printed) — Title

9/97/mn/in

TECHNICAL MEMORANDUM

RECLAMATION MONITORING RESULTS FOR THE COLUMBIA SITE

Mining Stormwater Discharge General Permit Certification No.: COR-040188

September 14, 1998

Introduction

The historic, inactive Columbia Tailings Site is one of eight areas for which a Colorado Stormwater Discharge Permit was issued to Atlantic Richfield Company in association with five approved Voluntary Cleanup Plans (VCUPs) implemented in and near the Town of Rico under the Voluntary Cleanup and Redevelopment Act (VCRA). Environmental baseline field work associated with this project was begun in the Spring of 1995, followed by engineering and reclamation planning activities. Mine waste remediation construction work was completed in 1996. The first annual revegetation inspection was completed in July 1997, in a qualitative manner, and remedial measures recommended. Remedial measures were completed by October 1997. On September 8, 1998 the second annual revegetation inspection of this site was completed and quantitative vegetation cover data collected by Cedar Creek Associates, Inc.

The following paragraphs detail the overall characteristics of the Colombia Tailings site and the results of the revegetation monitoring activities. The VCUP for this inactive mine waste site is described in the document *Voluntary Cleanup and Redevelopment Act Application for Columbia and Old Pro Patria Mill Tailings and Silver Swan East Wasterock Pile-Rico, Colorado* submitted in January 1996 to the Colorado Departrnent of Public Health and Environment by Atlantic Richfield Company, Rico Properties, L.L.C., and the Town of Rico. Remedial measures completed in 1997 are described in the document *Rico Site Remediation Project-1997 Maintenance Completion Report* submitted in October 1997 to ARCO Environmental Remediation L.L.C. by ESA Consultants, Inc.

General Site Characteristics and Site Remediation History

Original Disturbed Area : 3.3 acres with maximum sideslope angles of 25 percent.

Original Material Composition: Pyritic sandy loam tailings with low pH values (2.3 to 6.5) and Acid-Base Potential values (based on pyritic sulfur) of -153 and -378 tons of $CaCO_3$/1,000 tons of material.

1996 Remediation Summary: Grade tailings (~ 48,900 cu. yds.) to engineering specifications; complete runon and infiltration controls; amend tailings surface with liming material; apply 24 inches of cover soil materials (~9,000 cu. yds.); complete revegetation sequence (seedbed preparation, fertilization seeding, mulching); construct recreational facilities. All soil disturbing activities at the site were completed in September 1996.

Results of July 1997 Qualitative Monitoring: Revegetation success highly variable; no exposed tailings; surface stable except for some rills noted on west slope; 2 to 18 percent vegetation cover estimated visually with 50 to 55 percent surficial coarse fragment cover.

Remedial Measures Recommended in 1997: Repair rills, fertilize, reseed and/or mulch 2.25 acres of this site for which revegetation had not achieved the desired results at the end of the first growing season. The suggested remedial measures were completed in early October 1997.

Results of 1998 Quantitative Monitoring

Revegetation monitoring at the Columbia Tailings Site was completed on September 8, 1998. As requested in the permit issued by the Colorado Department of Public Health and Environment, vegetation cover was measured to determine whether existing surficial conditions warrant the termination of this permit following two growing seasons. Vegetation cover was measured using the "point-intercept" methodology. A lazer-powered "Optical-Point Bar" developed by Cedar Creek Associates, Inc. was employed to gather the plant cover data. To complete data collection, five ten-meter transects were located in areas selected as representative of plant cover across this 3.3 acre site. Point-intercept data was collected at 0.1-meter intervals along each 10 meter transect such that 100 data points were collected per transect. Each data point could represent a bare ground, litter, rock (coarse fragments > 2 mm. in size) or vegetation "hit". Vegetation hits were recorded by species or genus where a plant could not be identified to species level. A total of 500 data points were collected at the Columbia Tailings site. Statistical adequacy was not considered to be necessary as per the termination criteria specified in the stormwater permit issued.

Plant cover across the five transects traversed ranged from 23.0 to 42.0 percent with an average of 32.2 percent. Dominant species identified along the transects included *Bromus carinatus* (mountain brome), *Agropyron trachycaulum* (slender wheatgrass), and *Agrostis alba* (redtop). Twenty-one additional species were also found along the transects or were recorded as incidental species on the Columbia Tailings site. These species included grass, forb, and shrub life-forms, which included such species as *Festuca ovina* (sheep fescue), *Astragalus cicer* (cicer milkvetch), and a *Salix* (willow). The percent of surface covered by rock fragments ranged from 26.0 to 51.0 percent with an average of 42.4 percent. Litter and bare ground averaged 7.2 and 18.0 percent, respectively.

A copy of the plant cover data sheet completed in the field is included at the end of this Technical Memorandum, as are two representative photographs taken of the site during the field monitoring work.

Monitoring Data Summary and Proposed Vegetative Cover Criterion Revision

Across five representative transects, surface cover by plants and rock fragments averaged 32.2 and 42.2 percent, respectively. Together, plants and rock fragments covered an average of 74.4 percent of the revegetated surface of the Columbia Tailings. No rilling or gullying was observed anywhere on this site during the 1998 monitoring field work. Minor sheet erosion is assumed to have occurred but there is no evidence of soil accumulation at the toe of the constructed slopes. This site, presumably due to the high percent of surficial rock cover, exhibited little erosion in July of 1997. This situation continues on to the end of the 1998 growing season resulting in a stable site surface supporting an expanding, vigorous vegetation community.

The stormwater permit termination criterion for vegetation cover requires that "vegetation has been established with an average cover or density, over the previously disturbed area, of a minimum of 40 percent vegetative cover or 70 percent of the vegetative cover of a similar undisturbed site, which ever is higher....." The permit goes on to say that the Division may " after consultation with the permittee and upon good cause being shown, revise the cover requirement on a case-by-case basis".

ARCO requests that the revegetation criteria applicable to this site be revised to reflect the surficial conditions at the site and the materials making up the seedbed, growth media, and substrate materials. To require that the average vegetation cover values be compared to the vegetative cover of a similar site would not be appropriate. There are no similar undisturbed sites which are underlain at 24 inches with amended pyritic tailings which is, in turn, underlain with graded pyritic tailings materials. The only undisturbed upland herbaceous vegetation communities known to exist in the area are mountain meadow communities which are typically underlain with more than 24 inches of quality soil material. Thus, a comparison with undisturbed meadow soils may not be appropriate. A requirement of a minimum of 40 percent cover could be appropriate under general circumstances though this criteria does not take into account the affect of the high surface rock fragment cover percentages typical of this site. (The high rock fragment content is characteristic of the local soil borrow material used to cover the amended tailings.) Both vegetation and surficial rock fragment cover will aid in stabilizing a graded surface and reducing long-term erodibility. In the case of the Columbia Tailings site, vegetation/surficial rock fragment cover ranges from 68 to 80 percent with an average of 74.4 percent. Given that no rills or gullies were found on site and that sheet erosion was minimal following two growing seasons, it seems appropriate to conclude that this site is stable, particularly considering that the two slope angles characterizing the facility are nearly level and 25 percent.

A request to revise the applicable criteria was submitted to the Colorado Department of Public Health and Environment at the time of permit application submittal in 1996. The criterion proposed by ARCO was

to achieve a minimum average cover of 50 percent by plant and rock fragments, combined, so long as such resulted in a stable surface. The agency personnel contacted in 1996 were receptive to this change, considering the characteristics of the project site and the materials which would form the final plant growth media, but deferred to accept such a criterion change until the time of proposed permit termination in 1998.

Other Significant Hydrologic Controls

In addition to the vegetation cover, other permanent hydrologic controls were constructed to isolate the reclaimed tailings from stormwater runoff events. These controls include: 1) a riprap and HDPE-lined ditch designed to intercept and divert upland runoff from up to a 100-year frequency design storm event away from the site; 2) compaction of the top 18 inches of tailings beneath the growth medium cover to minimize infiltration; 3) 1,000 linear feet of flood protection revetment (riprap) along the old railroad berm that separates the tailings pile from the Dolores River channel to protect against a 500-year frequency design flood event, and; 4) asphalting and graveling access roads and the constructed parking area

Request for Permit Termination

ARCO proposes that the criterion for successful revegetation be revised for the Columbia Tailings site to that previously submitted. ARCO also requests that the Department terminate the existing permit based on the plant and rock fragment cover values measured on site, observed stability of the site surface, and the construction of other significant hydrologic controls.

Color Photo(s)

The following pages contain color that does not appear in the scanned images.

To view the actual images, please contact the Superfund Records Center at (303) 312-6473.

PHOTO LOG OF THE COLUMBIA TAILINGS SITE

Photos Taken September 8, 1998

Photo #	Description
1	Near northern facility border looking south-level upper surface.
2	Near northern facility border looking south-level upper surface and eastern facility outslope.

1998 RICO Project Revegetation Success						CEDAR CREEK ASSOCIATES, INC.				
Sampling Area: Columbia Tailings (W Fork)						9/8/98	S. Viert/S. Long	Point Intercept Ground Cover		
Sample No.-->	1	2	3	4	5	1	2	3	4	5
Grass										
Bromus inermis	7		6	2	28	卌 II		卌 I	II	卌卌卌卌卌III
Agropyron trachycaulum	7	5	14	3	6	卌 II	卌	卌卌IIII	III	卌 I
Agrostis alba	4	4	3	30		IIII	IIII	III	卌卌卌卌卌卌	
Ag. smithii	1					I				
Ag. dasystachyum	1	3	1		3	I	III	I		III
Festuca ovina		6	9	5	1		卌 I	卌 IIII	卌	I
Phleum pratense		1		2			I		II	
Poa alpina		2					II			
Forbs										
Penstemon sp.	2				1	II				I
Lotus corniculatus	1					I				
Onobrychis viciifolia		1					I			
Astragalus cicer			1					I		
Linum lewisii					1					I
unidentifiable										
Shrubs										
						Agent's in weather control area (#4 transect)				
T.P. Cover	23	23	33	42	40					
Rock	49	51	46	26	40					
Litter	9	4	14	3	6					
Bare ground	19	22	6	29	14					
100%	✓	✓	✓	✓	✓	Incidentals:				

$n = 5$
$\bar{x} = 32.2$
$s^2 = 81.7$
$n_{min} = 4.6$ 70/80

Incidentals: Lolium, Fes ovi, Medsa, Hoju, Trifolium pratense, Medicago lupulina, Alsike clover, Ast cicer, Lils, Taof, Salix sp., Agsm, Polygonum aviculare, Lepidium ~~latifolium~~ perfoliatum